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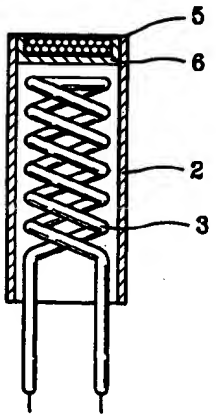
(54) Cathode for an electron tube.

(57) A cathode for an electron tube which comprises: a cup (6) provided in a sleeve (2); and a pellet (5) of an electron emissive materials including at least one oxide selected from the group consisting of europium oxide (Eu_2O_3), lanthanum oxide (La_2O_3) and scandium oxide (Sc_2O_3) in an amount of 1 to 20 wt %, based on the total amount of the electron emissive materials, and at least one carbonate selected from the group consisting of $BaCO_3$, $SrCO_3$ and $CaCO_3$; at least one reducing material selected from the group consisting of Ni, W, Mg, Si and Mo; and an oxide containing Ba. The cathode has a high current density and a long lifetime.

FIG.2



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Background of the Invention

The present invention relates to a cathode for an electron tube for use in such display devices as a picture tube, and more particularly, to a novel cathode for an electron tube having high current density and a long lifetime.

For the conventional thermoelectron emitting cathode for an electron tube which is used in a picture tubes and other display devices, a so-called "oxide cathode" which includes alkaline earth metal oxide layer having Ba as a main component on a metal base containing Ni as a main component and a small amount of Si, Mg, etc. as a reducing agent is widely used. This oxide cathode emits electrons provided by free atoms produced from oxides through the reaction between reducing agents in the metal base and oxides.

FIG. 1 illustrates a schematic cross-sectional view of the conventional oxide cathode. The cathode comprises a circular pellet-type metal base 1, circular tube-type sleeve 2 and electron emissive material layer 4 which is coated and formed on the metal base 1 and contains a barium compound as a main component. The reference numeral 3 designates a heater for heating the cathode.

Among the constituting components, the electron emissive material layer is formed by the following method. That is, carbonate powder which contains barium carbonate as a main component is mixed with solvents in which nitrocellulose or so is dissolved. The mixture is then coated on the base metal by spray or electrodeposition, etc. The cathode having each components is later installed in a cathode ray tube and then assembled in an electron tube. During an exhaust process to make the inside of the electron tube vacuous, the cathode is heated to about 1000 • C. At this time, barium carbonate in the electron emissive material layer thermally decomposes and changes into barium oxide as the following chemical formula.

$$BaCO_3 \rightarrow BaO + CO_2\uparrow \quad (1)$$

The produced barium oxide reacts with the reducing agents in the metal base, Si and Mg at the interface of the metal base and the electron emissive material layer during the cathode operation as the following chemical formula.

$$BaO + Mg \rightarrow MgO + Ba\uparrow \quad (2)$$

$$4BaO + Si \rightarrow Ba_2SiO_4 + 2Ba\uparrow \quad (3)$$

The thus-produced free Ba contributes to an electron emission. However, at this time, MgO and Ba_2SiO_4 also are produced as described in formulae (2) and (3) at the interface between electron emissive material layer and the metal base. This reaction product accumulates around the interface and becomes a barrier, called an "interlayer" which interrupts diffusion of Mg or Si from the metal base. This makes free Ba production difficult. The interlayer results in undesirable effects such as a reduction in cathode lifetime. Moreover, since the interlayer has high resistance and interrupts the electron emission current flow, the problem of restriction of emittable current density occurs, which in turn results in dissatisfactory requirements for large electron tubes having high luminance.

An impregnated-type cathode is a kind of cathode satisfying the above requirements and is manufactured by the process including melting electron emissive materials under a reducing atmosphere or in a vacuum and impregnating a porous metal base with the melted electron emissive materials. The impregnated cathode can realise the high current density and long lifetime. However, the manufacturing process is complicated and the operation temperature is higher; as much as 300-400 • C higher than that of a carbonate cathode, and can be as high as 1100 • C or more. Therefore, the electrode materials should be changed as those which are heat-resistant and this heightens production cost.

Summary of the Invention

An object of the present invention considering the above-mentioned problems and solving the problem of lifetime reduction owing to the interlayer is to provide a cathode for an electron tube which has the characteristics of stable electron emission over a long time and high current density.

According to one aspect of the invention there is provided a cathode for an electron tube comprising:

a cup provided in a sleeve; and

a pellet of an electron emissive materials including:

at least one oxide selected from the group consisting of europium oxide (Eu_2O_3), lanthanum oxide (La_2O_3), and scandium oxide (SC_2O_3) in an amount of 1 to 20 wt% based on the total amount of the electron emissive materials, and at least one carbonate selected from the group consisting of $BaCO_3$, $SrCO_3$ and $CaCO_3$;

at least one reducing material selected from the group consisting of Ni, W, Mg, Si and Mo; and

an oxide containing Ba.

The preferred oxide containing Ba is at least one Ba compound selected from the group consisting of $BaO \cdot CaO \cdot Al_2O_3$, $Ba_3Ga_2O_6$, $Ba_3Ir_2O_6$, $Ba_4Ir_4O_7$, $Ba_2V_2O_7$, $Ba_3In_2O_6$ and $BaBeO_2$.

Brief Description of the Drawings

The above objects and other advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof, by way of example only, with reference to the attached drawings in which:

Figure 1 illustrates a schematic cross-sectional view of the conventional; oxide cathode;

Figure 2 illustrates a schematic cross-sectional view of a cathode for an electron tube according to one aspect of the present invention;

Figure 3 is a graph representing lifetime characteristics of the conventional cathode versus a cathode according to one embodiment of the present invention; and

Figure 4 is a graph representing current density with respect to the operating temperatures of the conventional cathode and the cathode according to one embodiment of the present invention.

Detailed description of the Invention

The cathode of the present invention is manufactured by removing the metal base portion from the conventional oxide cathode, covering a pellet made of electron emissive materials with a cup, and attaching the cup in an upper part and inner face of a sleeve by resistance welding, laser welding, etc. The cathode is practical and easy to manufacture.

The cathode for an electron tube will be described in detail according to the manufacturing process referring to Figure 2.

First, carbonate of alkaline earth metal containing barium as a main component and reducing metal are mixed at a mixing ratio of between 1:9 and 4:6 (e.g. 1:9, 2:8, 3:7, 4:6, etc.) and homogeneously mixed by means of a mortar. The preferred reducing metal is at least one metal selected from the group consisting of Ni, Mg, W, Si and Mo, and the preferred size of ranges from 2~7μm. More preferably, the metal is heat treated under vacuum or a reducing atmosphere such as a hydrogen gas atmosphere.

In order to improve the electron emission characteristic, at least one oxide selected from the rare earth compound group consisting of europium oxide (Eu_2O_3), lanthanum oxide (La_2O_3) and scandium oxide (Sc_2O_3) may be added to the carbonate in an amount of 1 to 20 wt% based on the total weight of the electron emissive material.

Furthermore, in order to lower the operation temperature of the cathode and induce stable electron emission, at least one oxide containing barium selected from the group consisting of $BaO \cdot CaO \cdot Al_2O_3$, $Ba_3Ga_2O_6$, $Ba_3Ir_2O_6$, $Ba_4Ir_4O_7$, $Ba_2V_2O_7$, $Ba_3In_2O_6$ and $BaBeO_2$ is added and then mixed using a mortar. Since barium is slowly provided from these compounds, the diminution of the electron emission characteristic is compensated and electron emission from the cathode becomes stable. The mixing ratio of the carbonate and barium-containing oxide ranges preferebly from 7:3 to 1:1.

The obtained mixture is press moulded into a predetermined size. From repeated experiment by the inventors, the press molding is preferably carried out at 5~10ton/cm^2 pressure. The porosity of the packet may be controlled by controlling the pressure when press molding. Through the porosity controlling, lifetime reduction and the lowering of current density may both be prevented. As the porosity increases, the current density and the evaporating amount of barium increase and thus the lifetime of the cathode decreases. As the porosity decreases, the lifetime characteristic is improved but high current density could not be obtained. According to the repeated experiment by the inventors, the cathode having appropriate current density characteristic and lifetime characteristic may be manufactured when the porosity of the pellet is about from 18 to 40%.

The manufactured pellet is preferably heat-treated under vacuum or a reducing atmosphere so as to activate the decomposition of the CO_2 present in the carbonate and to use immediately after assembling without a separate decomposition process. The heat treatment is preferably carried out at a temperature range of 800~1000°C for 30~90 minutes.

The thus-obtained pellet (5) is covered with a cup (6) made of heat-resistant metal. The cup (6) is laser molded to the upper portion and inner part of a sleeve (2), and a heater (3) is provided in the sleeve (2) to finish a cathode according to the present invention as illustrated in FIG.2.

The preferred embodiment of the present invention will be described in detail below. However, the present invention is not restricted to the following example.

Example

Ni was added to a three-element carbonate having a weight mixing ratio of Ba:Sr:Ca as 57:39:4, and mixed using a mortar. 30 wt% based on the Sum with the carbonate of barium•calcium•aluminate ($BaO \cdot CaO \cdot Al_2O_3$) prepared by baking a mixture of $BaCO_3$, Al_2O_3 and $CaCO_3$ at a predetermined ratio, and 1 wt% of europium oxide (Eu_2O_3) based on the total amount of the electron emissive materials were added to the thus-obtained mixture and mixed further using the mortar. The mixture was compacted in a metal mold and press-molded

at about 10ton/cm^2 to manufacture a pellet. The pellet was heat-treated under a hydrogen atmosphere at about 900 • C for about 50 minutes. The heat-treated pellet was covered with a cup made of a heat-resistant metal, and this assembly was laser-molded on the upper portion and inner side of a sleeve as shown in FIG .2. A heater was provided in the sleeve to manufacture a cathode for an electron tube of the present invention.

In FIG. 3, a graph representing the lifetime characteristic of the conventional cathode with respect to that of the cathode according to the present invention is illustrated. In the graph, "a" corresponds to the conventional impregnated-type cathode, "b" corresponds to the cathode for an electron tube of the present invention and "c" corresponds to the conventional oxide cathode. From the graph, it is confirmed that the lifetime characteristic of the cathode of the present invention is somewhat lower and almost similar when compared with that of the conventional impregnated cathode, and has even better efficiency than that of the conventional oxide cathode.

FIG.4 is a graph representing current density with respect to the operating temperature of the conventional cathode and cathode of the present invention. In this figure, "a" corresponds to the conventional impregnated cathode, "b" corresponds to the cathode of the present invention and "c" corresponds to the conventional oxide cathode. The operating temperature of the impregnated cathode is too high (approximately about 1100 • C) even though it has the highest current density, while the current density of the conventional oxide cathode is too low even though the operation temperature is low. For the cathode of the present invention, the operation temperature is lower (by as much as 200 • C) than that of the impregnated cathode and the current density is as high as that of the impregnated cathode, which confirms that the cathode of the present invention is very practical one.

As described above, the cathode of the present invention has the characteristic of a stable electron emission and a low operation temperature of about 800~900 • C. The operation temperature is about 200 • C lower than that for the impregnated cathode. Therefore, the use of high-melting-point metals are not necessary, which lowers production costs.

Moreover, since the production of the interlayer is restrained in the cathode of the present invention, a current density as high as 6~8A/cm^2 could be achieved, while the lifetime thereof is lengthened when is compared with that of the conventional oxide cathode.

While the present invention has been particularly shown and described with reference to particular embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be effected therein without departing from the spirit and scope of the invention as defined by the appended claims.

Claims

1. A cathode for an electron tube comprising:
   a cup (6) provided in a sleeve (2); and
   a pellet (5) of an electron emissive materials including:
   at least one oxide selected from the group consisting of europium oxide (Eu_2O_3), lanthanum oxide (La_2O_3) and scandium oxide (Sc_2O_3) in an amount of 1 to 20 wt% based on the total amount of the electron emissive materials, and at least one carbonate selected from the group consisting of $BaCO_3$, $SrCO_3$ and $CaCO_3$;
   at least one reducing material selected from the group consisting of Ni, W, Mg, Si and Mo; and
   an oxide containing Ba.

2. A cathode for an electron tube as claimed in claim 1, wherein said oxide containing Ba is at least one Ba compound selected from the group consisting of $BaO \cdot CaO \cdot Al_2O_3$, $Ba_3Ga_2O_6$, $Ba_3Ir_2O_6$, $Ba_4Ir_4O_7$, $Ba_2V_2O_7$, $Ba_3In_2O_6$ and $BaBeO_2$.

3. A cathode for an electron tube as claimed in claim 1, wherein a mixing ratio of said carbonate and said oxide containing Ba ranges from 7:3 to 1:1.

4. A cathode for an electron tube as claimed in any one of claims 1 to 3 wherein the ratio of said carbonate to said reducing material is from 1:9 to 4:6.

5. An electron emissive material comprising an alkaline earth metal carbonate, and a reducing material, characterised in that the components are mixed throughout the electron emissive material.

6. An electron emissive material as claimed in claim 5 wherein the material is in the form of a pellet, the alkaline earth metal carbonate is selected from the group consisting of $BaCO_3$, $SrCO_3$ and $CaCO_3$, the reducing material is selected from the group consisting of Ni, W, Mg, Si and Mo, and the material includes at least one oxide selected from the group consisting of Eu_2O_3, La_2O_3 and Sc_2O_3.

7. A cathode comprising an electron emissive material as claimed in claim 5 or claim 6 supported by a support means (6).

8. A cathode comprising a support means (6) and an electron emissive material (5) characterised in that the support means (6) is in the form of a cup and the electron emissive material (5) is in the form of a pellet located within the cup.

9. A process for forming an electron emissive material for use in a cathode comprising the steps of:

mixing a reducing material, an alkaline earth metal carbonate and a barium oxide together; and

forming the mixture under pressure into a pellet.

10. A process as claimed in claim 9 wherein the mixture is formed in to a pellet by press moulding under a pressure of between 5 to 10 ton/cm^2 and the pellet is heat treated in a vacuum or a reducing gas at a temperature of between 800 to 1,000 °C for a period of between 30 to 90 minutes.

FIG.1
(PRIOR ART)

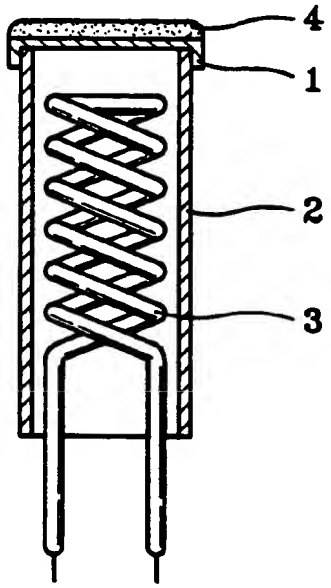


FIG.2

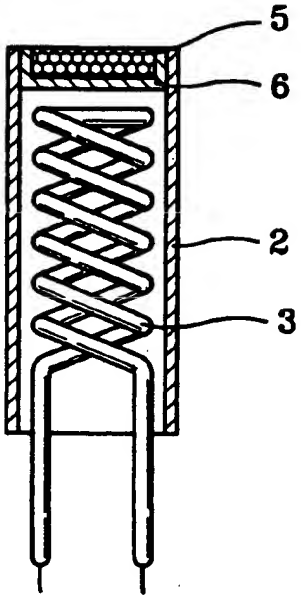


FIG.3

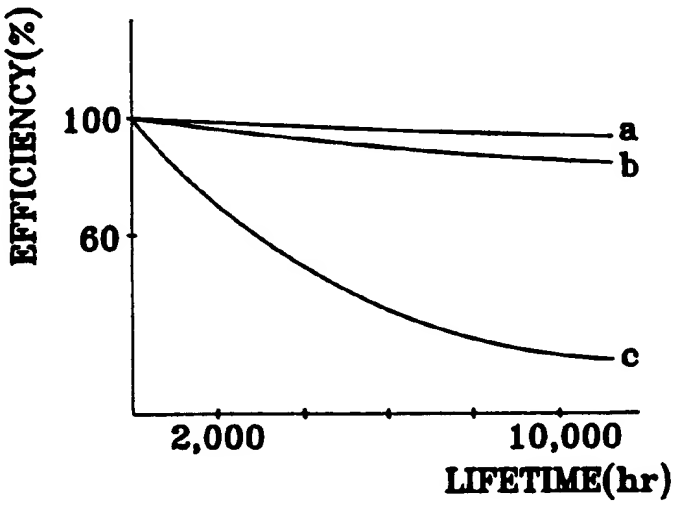
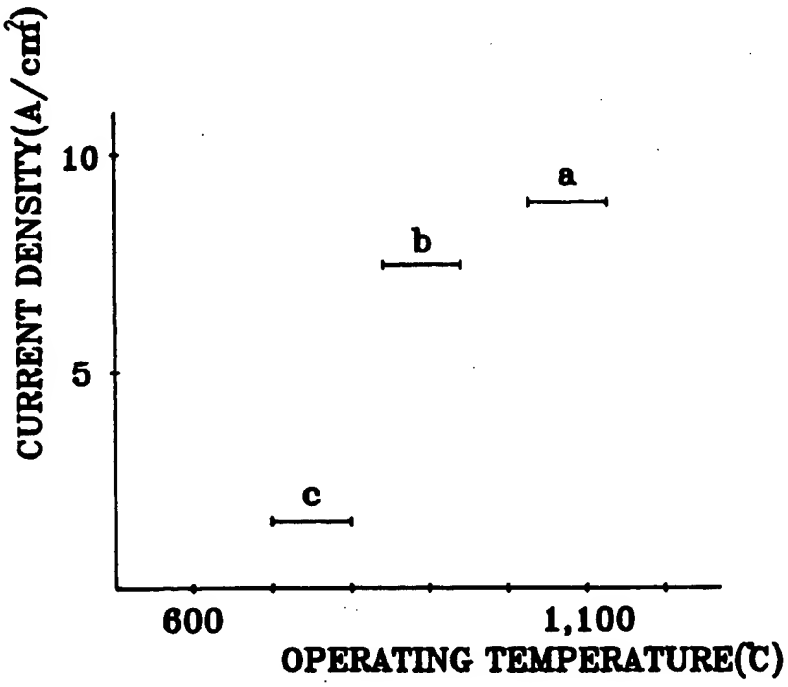


FIG.4



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EUROPEAN SEARCH REPORT

Application Number
EP 93 30 9889

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	FR-A-700 645 (A.LEDERER) * page 1, line 33 - line 47; claim 1 *	5,9	H01J1/14
X	FR-A-1 086 891 (COMPAGNIE GENERALE DE TELEGRAPHIE SANS FIL) *résumé*	5,9,10	
Y	EP-A-0 210 805 (MITSUBISHI DENKI KK) * claims 1-10 *	1	
Y	EP-A-0 436 360 (SAMSUNG ELECTRON DEVICES) * claim 1; figure 1 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 114 (E-730) (3462) 20 March 1989 & JP-A-63 285 836 (MITSUBISHI ELECTRIC CORP) * abstract *	1	
A	GB-A-182 817 (GESELLSCHAFT FUR DRAHTLOSE TELEGRAPHIE) * claims 1-3 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H01J
A	EP-A-0 204 477 (MITSUBISHI DENKI KK) * claims 1,2,6 *	1	
X	GB-A-2 203 588 (C.E. MALONEY) * claims 1,6,9,11 *	5,9	
A	EP-A-0 516 503 (THOMSON TUBES ELECTRONIQUES) * claims 1,2 *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 December 1994	VAN DEN BULCKE, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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